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Leah Marie Roberts

University of South Carolina - Columbia, leahmr@email.sc.edu

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AN EVALUATION OF THE SUSTAINABILITY OF THE PALM OIL INDUSTRY

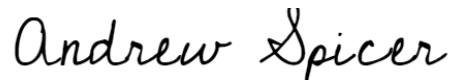
By

Leah Marie Roberts

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Approved:



Dr. Andrew Spicer
Director of Thesis



Dr. Sali Li
Second Reader

Steve Lynn, Dean
For South Carolina Honors College

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Thesis Summary

The goal of this thesis is to critically analyze the sustainability of the rapidly growing palm oil industry in order to diagnose whether the benefits of production outweigh the varied costs incurred by stakeholders, how the industry can be improved, and what analytical tools consumers can use to make better purchasing decisions. The body of the thesis begins with a discussion on sustainability definitions and determines that for this paper, sustainability will be defined as analyzing the socioeconomic and environmental effects of palm oil and how they affect different actors of the value chain in order to allow for prescriptions of improvement. The next section identifies the main stakeholders of the industry as larger plantations/companies, smallholder farmers, the communities in producing countries, governments, certifying boards, and consumers. It is determined that although there are uneven power shares among the value chain, the actors are all influenced by the decisions and pressures of the others. Next, preexisting literature including case studies and scientific studies are analyzed in order to explain both the positive and negative socioeconomic and environmental effects that palm oil has. It is determined that the harms discussed are not unique to palm oil and are often less detrimental than that of alternative industries. Therefore, external and internal stakeholders need to work together to influence positive change versus denouncing the industry altogether. I suggest that the focus should be on encouraging more sustainability certification and regulation, supporting smallholders with education and resources, and demanding more accountability from the industry. To conclude, I discuss how this research and analysis can be applied to better understand complex industries and sustainability labels to make informed consumer and activist decisions.

Introduction

A young Girl Scout named Olivia Chaffin went from selling over 600 boxes of cookies in one year to not selling them at all (McDowell & Mason, 2020). This change in heart was due to the inclusion of palm oil as a major ingredient in the cookies. Over a decade ago, the Girl Scouts of the USA joined the RSPO, a major palm oil certifier, after the campaigning of two Michigan Girl Scouts. With this, they promised to use sustainable palm oil in the Girl Scouts' 200 million annual boxes of cookies. However, this promise has been carried out half-heartedly, as Olivia discovered. The "certified sustainable" palm oil used is actually mixed, meaning it is blended with oil from unsustainable supply chains. Olivia was left wondering how this organization, which builds female leadership with the goal of making the world a better place, chooses to use an ingredient that—in her eyes—does the exact opposite? Why are they okay with an oil that possibly destroys rainforests, harms wildlife, and exploits child labor? What is the best way to prevent this?

These are similar questions to those I had while standing in a palm oil plantation in El Progreso, Honduras, directly behind the village where I was staying. I learned how plantations—such as that very one—were forcefully taking the autonomy of local farmers and limiting the biodiversity and long-term usefulness of land, and I wondered why it was happening. I asked myself why it was the first time I heard of palm oil, an ingredient that you can find in 75 percent of cosmetic brands and in half of the supermarket shelves, including in infant formula, Magnum ice cream, bubble gum, and Cap'n Crunch cereal (McDowell & Mason, 2020). How could I change my behavior—and how could industry players change theirs—to limit the harmful effects of palm oil?

Olivia's response to her questions was to petition the Girl Scouts of the USA to completely remove palm oil from their cookies (McDowell & Mason, 2020). My response was to research the sustainability of this 65-billion-dollar global industry in order to determine how its mass cultivation is affecting local communities and other actors, as well as whether efforts to certify are genuine and impactful. More so, I am interested in the choices that arise from the notion of sustainable products—at what point are people willing to make tradeoffs between cost/ease and sustainability? As someone who is an avid volunteer and who cares deeply about environmental and social issues, nine out of ten times I still find myself reaching for the cheapest item at the grocery store. It is easy for me to denounce the issues with palm oil and other global industries, but at what point will I change my consumption habits? Thus, I am interested in how people, at both an individual level and as a society/nation, make these tradeoffs. The purposes of this paper are to equip myself and readers with the information to better make purchasing decisions about palm oil, as well as the tools to think critically about other consumption habits, acknowledging all the effects those tradeoffs have on people and ecosystems near and far.

Palm oil is one of the leading vegetable oils produced and consumed globally, accounting for a huge market share of oil consumption and international trade (Alam et al., 2015). It is used in food products, cosmetics, animal feed, bio energy, and more. Consumed worldwide, palm oil accounts for 21 percent of the global fats and oil supply, with 80 percent of its global production used for food (Boons & Mendoza, 2010). Although under two percent of current palm oil consumption is used for electricity production, countries in the European Union such as the Netherlands have been encouraging this usage to grow, effectively diversifying the product, and setting the groundwork for increased demand. It has also caught interest from financial sectors as

it is being traded at international stock exchanges as a product for speculative investment (Boons & Mendoza, 2010).

Palm oil was originally cultivated in the early 1900s in colonial Nigeria, but it underwent rapid industrialization when the Dutch introduced it to South East Asia (Noor et al., 2017). Once introduced to Malaysia, the government saw palm oil as a way to diversify from rubber production, and it soon became the dominant cash crop in Malaysia and then in Indonesia (Noor et al., 2017). Nevertheless, global consumption of palm oil is a relatively new trend, with the production increasing from 1.2 million tons in 1962 to 25 million tons in 2002. This growth in production is mostly due to industry expansion in South East Asia, but there has been growth in Latin America and Africa as well.

Throughout the last decade, increased demand has allowed for the palm oil industry to increase production capacity by 128 percent, as 58 million additional tons are produced yearly (Alam et al, 2015). This quick, steady growth of palm oil cultivation and use is mostly due to the comparative advantages that it holds over other forms of oil. The productive yield of crude palm oil is 3-5 tons annually per hectare of land, which is more efficient than that of soybean, sunflower, and rapeseed oil (Boons & Mendoza, 2010). This means that more palm oil can be produced with less land and resources than its alternatives. Another advantage leading to the adoption of palm oil is that its production costs are lower than that of alternative oils, leading to better margins for producers and cheaper prices throughout the value chain. Therefore, it seemed as though palm oil was a solution to the sustainability shortcomings of other oils.

The product chain of palm oil is buyer driven. Such product chains are led by large retailers, marketers and branded manufacturers that work to coordinate and develop decentralized production networks in developing countries using market exchanges (Boons &

Mendoza, 2010). Therefore, the growth of the industry is dependent on consumer demand. Recently, this increased demand for palm oil has been driven by the growing middle class in large emerging economies such as China. However, there has also been active promotion by governments in producing countries due to the productivity, supply stability, and long-term market prospects of palm oil (Brandão & Schoneveld, 2015).

Though oil palm has proven itself one of the most efficient oil crops, the rapid growth calls into question the sustainability of the crop (Noor et al., 2017). Because of the global demand, and the expanding use of palm oil by Northern consumer goods manufacturers, palm oil has become a clear target for societal and consumer activism (Pacheco et al., 2020). The shortcomings and potentially detrimental effects of the palm oil industry have been put on a spotlight, causing many controversial opinions about the current and future production. In some instances, palm oil has contributed greatly to the economy of producing countries, employed millions of rural workers, and improved infrastructure such as health care and educational access (Lim & Biswas, 2015). However, it has also disrupted regional economies, led to biodiversity loss, and created social issues (Pacheco et al., 2020). It is important to note that the criticisms discussed are related to the establishment and cultivation of palm oil, not necessarily the crop itself. Thus, the goal of this paper is to attempt to diagnose whether the benefits of palm oil cultivation outweigh the socioeconomic and environmental costs incurred by stakeholders surrounding palm oil plantations. In addition, it will attempt to address how the sustainability of palm oil can be improved and offer advice to how the Girl Scout should continue her activism.

Definitions of Sustainability

In order to analyze the palm oil industry and develop any conclusions, it is necessary to define what definitions of sustainability are to be used. In general, sustainability definitions “are the result of activities of involved actors which over time construe criteria of what are relevant ecological impacts to consider, what social issues need to be addressed, and in what way economic value is to be measured” (Boons & Mendoza, 2010). With agricultural production in particular, it is common that the relevant issues regarding sustainability refer to increased efficiency of production, meaning that yield increases while less land, water, and fertilizer is used (Noor et al., 2017). This definition, however, fails to focus on important environmental and social influences. It is important to mold the definition of sustainability to actors in the product chain of palm oil, as well as the actors that attempt to influence the chain’s material and energy flows (Boons & Mendoza, 2010). Thus, for the purposes of this paper, the definition of sustainability used will need to be expanded.

A study conducted in Colombia and The Netherlands which included interviews with actors and influencers of the product chain of palm oil identified six sustainability themes relevant to palm oil (Boons & Mendoza, 2010). These included the socio-economic well-being of small-scale farmers, the use of chemical fertilizers, methane capture from wastewater treatment systems, preservations of local ecosystems and their resources, protected areas for biodiversity conservation and sustainability criteria development. Chye Ing Lim, a researcher from Curtin University Malaysia, offers a definition of sustainable palm oil production that is similar but with slightly different focuses, stating that it is production that encourages inter and intra-generational equity, protects the environment, improves commercial operations, and shares economic success with local communities through fair trade and employment (Lim & Biswas, 2015). He argues that “there is a need for a holistic sustainability assessment method for palm oil

production in order to identify the area of strengths and weaknesses, which will enable decision makers to improve the supply chain sustainability practices, and hence offer more confidence to the consumers” (Lim & Biswas, 2015).

Therefore, sustainability definitions not only help explain the current successes and pitfalls of the industry, but they allow for prescriptions of improvement that will help stakeholders at every step of the value chain. Thus, for the purposes of this paper, sustainability will be viewed as a mix of those sustainability definitions offered, analyzing the socioeconomic and environmental effects of palm oil on different actors of the value chain of palm oil. Using this sustainability assessment will act as a tool to identify, predict, and evaluate potential impacts of palm oil and provide options for circumventing the barriers to achieving sustainability (Lim & Biswas, 2015).

Stakeholder Analysis

In order to analyze its sustainability, the major stakeholders of the palm oil industry must be studied. The research seeks to ask who makes the decisions for the industry and chooses what protections to put in place. Who actually implements changes to protect the environment and the communities? Whose values and motives have the most power to influence these choices? The way stakeholders interact and influence one another will help to answer these questions. For the purposes of this paper, the major stakeholders that have been identified are industrial players/plantations, smallholder farmers, the communities in producing countries, governments, consumers, and certification boards.

The production of palm oil is derived from large companies and their plantations, along with outsourced production from external parties and smallholder growers. For example, in Indonesia and Malaysia, seven palm oil groups control 60 percent of the countries' supply of fresh fruit bunches (Pacheco et al., 2020). This group has an even larger market share in the processing and trade of crude palm oil, controlling an estimated 90 percent. These groups supply crude palm oil to large consumer goods manufacturers and retailers, as well as produce and market food products, cosmetics, chemicals, and pharmaceuticals. Similar industrial organization is found in Brazil, where nine large companies make up the majority of production, using a combination of company owned and managed plantations, as well as contracted third party growers in a pattern coined 'nucleus-outgrower arrangements' (Brandão & Schoneveld, 2015). However, these 'outgrowers' (outsourced growers) only account for 18.5 percent of production, with large plantations producing the majority. Reference the Appendix for a graph of this production breakdown.

This production pattern is present throughout the palm oil industry, with large companies relying on outsourcing. This includes third parties with independent third-party farmers, participants in profit sharing models, and contracted outgrowers (Pacheco et al., 2020). These outgrowers usually have exclusive sourcing arrangements with companies, and in return they receive input and technical support. The majority of these third-party farmers are smallholders, which means that their plantations are sized at less than 50 hectares, with some even smaller than five hectares (Noor et al., 2017). Smallholder farms are an important stakeholder to analyze—although large companies offer a lot of control over the palm oil industry, it is estimated that two-fifths of the global palm oil supply is produced on these smaller plantations. In many producing countries in Africa and Latin America, smallholders represent the majority of producers, but in Indonesia and Malaysia, smallholders only represent around 40 percent of production, with a large private sector producing the rest (Noor et al., 2017).

Within the category of smallholders, studies show that there is a broad mixture of economic standing, landholding, livelihood strategies, productivity, sustainability, and legality challenges (Pacheco et al., 2020). However, the majority of smallholders are on the smaller end of the spectrum (Noor et al., 2017). Palm oil can be a difficult crop for small farmers to start due to its high demands for fertilizer input and intensive labor requirements during the immature stages of cultivation (Noor et al., 2017). Therefore, due to their relationship and needs, smallholders are often dependent on the large palm oil companies, and thus are heavily influenced by their policies. Smallholders must follow the demands of production and ecological policies of the “bigholder” companies, meaning the large, vertically integrated palm oil companies (Boons & Mendoza, 2010). They also are reliant on the bigholders to filter and supply technology and information.

Bigholder monitoring of these smallholder farmers is not always efficient, especially with middlemen and intermediary buyers complicating the line of communication and the value chain. This leaves smallholders to comply the best they can, even if that vital expertise and direction from bigholders is lacking. Although smallholder farmers are aware of different practices that can be used for production, the majority have little to no knowledge about the sustainable criteria for production in the international palm oil market. Especially as sustainability norms are constantly changing, it becomes even more difficult for smallholders to comply. This threatens to alienate smallholders from the increasing demand for sustainable oil (Pacheco et al., 2020). Therefore, any sustainability motivations and ecological concerns tend to be more centered on protecting the land of their ancestors and children versus filling a consumer demand (Boons & Mendoza, 2010).

One of the major issues present in the value chain of palm oil is the difference in production yields between smallholder farmers and industrial plantations. On average, the productive yields of smallholders are between six and forty percent lower than the yields developed using best practices (Pacheco et al., 2020). Similarly, the yields from commercial plantations are usually 46 to 116 percent larger than those of smallholders. These yield differences demonstrate how smallholders are negatively affected by the failure to adopt best management practices or by the use of substandard planting material (Pacheco et al., 2020). It is also difficult for smallholders to expand their production independently. This is due to a high vertical integration of the supply chain, as it is in the best interests of bigholder companies to maintain tight control over its supply base (Brandão & Schoneveld, 2015). If smallholders are able to increase yields through improved productivity, it will increase their ability to compete, enhance income in rural areas, and reduce the pressure on their land (Pacheco et al., 2020).

Next, it is important to look at the role that national governments play in the palm oil industry. Since palm oil has the potential to stimulate socio-economic development in producer countries, governments actively influence the supply and demand of palm oil, as well as institute policies that producers must follow. For example, the Colombian national government sees palm oil as an opportunity to create more stable employment and income in vulnerable communities, as well as an opportunity to replace the cultivation of illegal crops such as cocaine (Boons & Mendoza, 2010). One of the biggest ways the government affects the industry is by the allocation and regulation of farming land. In order to legally grow palm oil, smallholder farmers are often reliant on the government allocating them land or providing them with credits to access the land (Boons & Mendoza, 2010). For example, in Indonesia, the government provides incentives to aid the private palm oil sector in accessing and expanding plantations (Purnomo et al., 2020). It has also created a range of partnerships with companies in order to increase land usage and support for smallholders. This support is a necessary step in Indonesia's target economic growth.

The Brazilian government has implemented similar support to expand the palm oil sector, but with an even greater value on smallholders. It has introduced credit incentives to those businesses that implement models inclusive of the poor, rural populations and create more shared value between the stakeholders (Brandão & Schoneveld, 2015). The government is committed to modernize smallholder production systems and address rural market failures in order to support family farms. Often times, communities build a sense of belonging and attachment to their land, whether due to ancestral history or as a means to support themselves. This motivates them to preserve the land and complete their work in ways that will not damage local ecosystems (Boons & Mendoza, 2010).

However, these government policies and initiatives come at a cost, with Brazil's industry having lower expansion and investment rates and lacking global competitiveness (Brandão & Schoneveld, 2015). National governments attempt to strike a balance between supporting sustainability and smaller stakeholders, while remaining economically successful and competitive. The governments of these producer countries are many times overburdened with the balance between local needs for economic growth, and global demands for protecting land and cultural spaces for palm oil and other globally traded commodities (Boons & Mendoza, 2010). In an attempt to have control over the industry, there are also some state-owned and ran plantations. However, this is not as common and therefore regulations for private farms are necessary for control.

Moving forward with the analysis of palm oil's controversy and sustainability issues, it is important to realize that these stakeholders are all interconnected, and therefore the effects of these issues affect the entire value chain of palm oil. The opportunity for successfully improving their standard of living is valuable to smallholder farmers, which is encouraged by the government. This pushes smallholders to create relationships with bigholders, who are reliant on those farmers to increase palm oil supply, and ultimately have to match sustainability improvement criteria by national governments (Boons & Mendoza, 2010).

At the end of the value chain, the most volatile stakeholder, is the consumer. There are two main markets for consumption with different buying objectives. The main market driving the global demand for palm oil are the rising middle-class consumers in Asian countries, namely in India and China (Noor et al., 2017). Their access to the market is reliant on low pricing—if pricing is too high, they will switch to other oil consumption. In this regard, the demand for palm oil is found to be fairly elastic. A study focused on the connection between dietary changes and

fiscal policy in Thailand found that a 54 percent sales tax on palm oil halved the energy intakes from palm oil consumption (Jensen et al., 2019). Thus, the current lack of ability to provide sustainably produced palm oil without increasing costs to this market creates difficulty for improving the industry in whole.

The other major market for consumption lies in European and Western markets, where there is a push for organic and sustainable products. The demand for palm oil in these markets is more volatile, since factors such as transparency and authenticity are important for consumer trust and demand, not just the price. To achieve such high sustainability standards, consumers look towards voluntary certification schemes and codes of conduct implemented by nongovernmental organizations (Boons & Mendoza, 2010). This demand demonstrates the connection that consumers and industry bigholders have in the value chain of palm oil. Bigholders recognize that these Western market demands offer incentive for sustainable production, and they have the expertise to put sustainability criteria into supply chain action (Boons & Mendoza, 2010). However, in order for these consumers to strongly affect the supply of sustainable palm oil and encourage the adoption of certification schemes, there needs to be enough consumers concerned with social and environmental issues to not only refuse to buy oil from retailers failing to provide sustainable, traceable palm oil, but to also be willing to pay a premium price for such a product (Boons & Mendoza, 2010).

Despite the USD 7 billion spent on palm oil following voluntary sustainability standards in 2016, there is a lack of current data showing this breakdown of Western consumers' ideals and concerns (Borrello et al., 2019). The fact is that not every consumer will care about sustainability. It is important to note that palm oil is not an isolated commodity, but a response to a rapid increase in vegetable oils in general (Palm Oil, n.d.). Due to its versatility and productivity, palm

oil has been a natural choice to fit this demand. It is able to meet the demand with a fraction of the land required by other oils (reference the appendix for a graph of this land use). Therefore, consumer perception of the industry is a reaction to the growth and criticisms, versus a knowing demand for it as a product. Furthermore, many consumers lack an understanding of what palm oil is, let alone its sustainability concerns (Borrello et al., 2019). This means that their purchasing decisions will not be influenced by the presence of sustainably sourced palm oil.

The resulting issue with having consumer markets with different goals—cheap, accessible palm oil in emerging markets and sustainable, ethical oil in Western markets—is the bifurcation of production into “green” and “brown” supply chains (Pacheco et al., 2020). Green supply chains are those following stricter sustainability standards and certification schemes, whereas brown supply chains are those failing to do so, mainly in order to save costs. Further, there is extreme difficulty, both financially and logistically, in keeping such supply chains separate and accurately represented. This difficulty has caused a lack of consumer confidence both within the palm oil industry and in other industries. For example, a case study of Walmart found that comprehensive marketing campaigns advertising sustainable products are challenging because of the public scrutiny facing any product claims (Spicer & Hyatt, 2017). Therefore, if sellers are not able to properly trace and communicate product supply chains and ethics, then customers lose trust about the given information. The transaction costs of these communications could lead to customers exiting the market altogether. The petition to remove palm oil from Girl Scout cookies is a prime example of bifurcated supply chains leading to consumer distrust and a potential loss of consumption.

Similar trends have occurred within the Dutch electrical sector, as biomass produced from palm oil offers the potential for ‘green electricity’ produced with renewable resources

(Boons & Mendoza, 2010). This supposed environmentally friendly electricity lost legitimacy when producers were not able to account for the specific origin of such products, negatively impacting consumer trust and electricity provider success. Public demand for transparency has motivated the formulation of criteria in the Netherlands that must be met for products to be declared ‘green electricity,’ similar to demands for palm oil certification that will later be discussed in further detail. Thus, the value chain of palm oil shows influences from many stakeholders, but ultimately the main power derives from what the final consumer is willing to buy and for how much, the regulations and supports national governments put into place, and the policies that industrial bigholders institute both for their plantations and their dependent smallholder farmers.

Socioeconomic Impacts

Money is undoubtedly one of the biggest reasons that people want to make or buy, and it is the reason that palm oil has become a global commodity. With lower production costs and production ten times that of other vegetable plants, the room for profits are enticing. According to experts, palm oil is an important source of foreign exchange, as well as a source of taxes and state income (Nasution et al., 2020). For example, in Malaysia, palm oil production is the fourth largest contributor to the national economy and represents a major driving force for the national agro-industry (Alam et al., 2015). In fact, it represents 71 percent of the contributions to the national agricultural land bank. Though it is clear that palm oil is a powerful revenue generator, it needs to be investigated which stakeholders share in these profits. Are profits staying in local communities where farmers actually produce the oil, or is the majority of it in the hands of large manufacturers simply using the oil as an ingredient? Is the income increasing the quality of life in developing countries? What is considered “fair” for a product with such a complex value

chain? These are the questions that this section intends to explore to aid in the stakeholder analysis.

One of the major impacts of palm oil celebrated is the increase in employment and income for rural workers, and along with that an improved regional economy. In Brazil, there are three major companies that provide nearly three quarters of industry employment. For each 13.9 hectares of land, a plantation generates one full-time employment (Brandão & Schoneveld, 2015). The majority of this employment (85 percent) is for manual laborers. Although the employment generated is smaller for contracted outgrowers, palm oil still generates more jobs on a per hectare basis than any other large agribusiness commodity grown in the Amazon. For example, soy plantations only generate one job per 200 hectares—almost 15 times more land needed per additional job. This has totaled to 16,067 people employed in Brazil’s palm oil plantations, in addition to those working outgrower schemes.

Not only do industry investors offer employment in Brazil, but they also provide competitive employment packages, as well as union relationships which make employment more secure. In addition, the increased income can influence other aspects of the industry. As farmers earn an improved income from their production systems, they are motivated to keep the systems sustainable in order to preserve their land, productivity, and profits (Nasution et al., 2020). However, these benefits circle back to the question of tradeoffs between economical gain and social values. The higher wages and benefits provided by those large Brazilian companies make it hard for smaller companies to compete or to retain experienced workers. In addition, these localized benefits harm the overall success of the industry in Brazil. Employment costs are the highest out of all 44 producer countries, including three times the cost per employee in Indonesia, which makes it hard to compete with the lower prices of other producing countries.

In the Nagan Raya District in Aceh, Indonesia, palm oil plants have come a mainstay of the community's economy (Nasution et al., 2020). Smallholder farmers produce 1,046,365 tons of fresh fruit bunches (FFB) from which palm oil is then extracted. As of the date of the study in March 2020, each farmer's family was allocated 4,104,248 Rupiahs, around 294 U.S. Dollars, per month. Although this income seems low for Western standards, it meets the farmers' income standards of 4.16 million Rupiahs per month (Nasution et al., 2020). Palm oil has also been shown to increase demand for other sectors, increasing income besides just that of its own industry. A simulation was created for a region in Papua, Indonesia using an input-output model which found that palm oil expansion would have a multiplier effect of 1.55 (Dürr, 2017). This meant that a 9.7 billion USD investment in the sector would lead to an additional output of 15 billion USD for Papua's economy. Although the majority of this output would be due to palm oil revenue, 25 percent would be caused by its influence on other sectors as the regional economy grows. Palm oil also serves as a source for cheap food for the populations in these communities that often struggle to feed their families (Nasution et al., 2020).

Nevertheless, not all regional economies benefit from palm oil. Experts have criticized the industry for disrupting the stability of economic growth, as well as reducing community income from existing sources (Nasution et al., 2020). The European Union has even heavily criticized this economic disruption, despite itself receiving a large proportion of economic benefits itself due to its downstream palm oil industry. Sixteen EU members countries have employed 117 thousand people, generated GDP of 5.8 billion euros, and received tax revenues of 2.6 billion euros due to palm oil. But their criticisms argue that more economic benefits are staying with the value-added services in those developed nations than with those producing the palm oil. This criticism is backed by other experts, who claim that palm oil generates fewer jobs

on a regional level compared to small-scale agricultural products with small to medium trading and processing sectors (Dürr, 2017). They argue that even though the actual cultivation of palm oil requires more labor, the forward and backward sectors of other products such as maize offer more aggregated jobs. In addition, the profits provided by those smaller farms stays within local regions, whereas those of palm oil are transferred out as value is added elsewhere such as in metropolitan areas or abroad. This is especially due to palm oil's vertically integrated value chain, where profits are given to national and transnational companies. Although palm oil provides more overall value per hectare of land, industries such as corn cultivation in Guatemala provide more localized wealth for regional economies and therefore could be more beneficial to those regions than expanded palm oil plantations (Dürr, 2017). This proposes an issue to the ideals of fairness in the palm oil industry, as the regions that are creating wealth and GDP increases are not always the ones that are benefiting from it. It is the larger, integrated firms who are benefiting from the value creation of palm oil.

Next, the social impacts of the palm oil industry must be analyzed to see how the industry and its search for profits both benefits and hurts communities. Along with increased income usually comes improvements to quality of life. This has been showed in many ways with the palm oil industry. For starters, the social statuses of farmers are increased as their income increases (Nasution et al., 2020). The possibility of success gives farmers a purpose to their work and pride in their accomplishments. Studies in the Nagan Raya District in Indonesia have also found that the industry has fulfilled more financial and social needs for rural people than other agricultural industries. This includes an increase in the education and financial empowerment and independence of community members due to the impact of Corporate Social Responsibility programs.

In addition, palm oil plantations have led to increased infrastructure built in rural areas in Indonesia that increase the social activities and quality of life of communities (Nasution et al., 2020). This infrastructure includes health and educational facilities, Islamic boarding schools called pesantrens, and prayer rooms. These all help to improve the physical, mental, and spiritual health of farmers and their families. It is not always the case that palm oil expansion leads to expanded infrastructure and community empowerment. Brazil, for example, has struggled with increased pressure on existing local health and educational services as workers migrate to these areas to work on plantations (Brandão & Schoneveld, 2015). The existing infrastructure cannot keep up with increased migration, but there have been somewhat successful efforts to make this migration less volatile. Nevertheless, there appears to be an overall improvement in resources and infrastructure due to palm oil production,

Moving on to community relationships, researchers have found positive relationships between plantation management and workers in the Aceh region (Nasution et al., 2020). This is due to optimized human resources and positive social interaction with management programs through farmers' social gatherings, routine recitations, and more. Unfortunately, these harmonious relationships are not always the case within the palm oil industry. Social conflicts have arisen in many instances, including between employees and companies regarding labor relations. Moreover, many conflicts have occurred between companies and the communities they enter, especially surrounding land ownership rights. In these local areas, it is somewhat common for locals and indigenous groups to hold land for generations, but not have the legal title for it. Therefore, companies come in and cause local residents to relocate, or ignore the land rights that residents might actually have (Nasution et al., 2020). Once companies come in, the conditions of

the surrounding communities and indigenous people are often neglected. This disruption causes a lot of social strife and criticisms for the intrusion of palm oil on locals.

With these industry and livelihood changes also comes changes in social cultural values, which can be upsetting to local community members. Conflicts and social jealousy can also arise as migrant workers come and mix with local residents (Nasution et al., 2020). In Brazil, seasonal in-migration has also caused an increase of violent crime, prostitution, illegal land holding, and drug and alcohol abuse due to the economic and social disruptions when temporary workers leave (Brandão & Schoneveld, 2015). Efforts to hire more locally and permanently have helped mitigate these issues, though. Therefore, some social conflicts, such as increased crime, are not inherent to the palm oil industry and can be improved so as to not have lasting effects. But how does one place a value on something so subjective as cultural changes? Are these changes unique to palm oil, or are they unavoidable as time progresses and a place develops economically? How much of an input do these community members receive? These are questions that cannot necessarily be answered objectively, especially by outsiders to the community. Nevertheless, they are important to consider when analyzing the effects and the sustainability of the industry.

Yet still, some populations may face graver effects within the palm oil industry. After speaking to over 130 workers at nearly 25 companies in the palm oil industry, Associated Press reporters found instances of rape, forced labor trafficking, and slavery (McDowell & Mason, 2020). One of the biggest concerns, especially one that Western consumers and activists focus on, is the potential existence of child labor. The United Nations Labor Organization has estimated that 1.5 million children labor in Indonesia's overall agricultural sector, and government reports have estimated more than 33,000 children work in Indonesia's industry (McDowell & Mason, 2020). These kids earn little to no pay, are exposed to hazardous

chemicals and conditions, are vulnerable to trafficking or abuse, and lack schooling. Child labor in the palm oil industry has been identified as a problem by rights groups, the United Nations, and the U.S. government. However, there is a lack of evidence showing whether child labor is more persistent with the cultivation of palm oil than in other agricultural industries. Clearly child labor is a huge problem, but it is not unique to palm oil. Thus, the important questions become how to institute safeguards in the industry to prevent or report instances of child labor. Is it also possible that as palm oil allows for increased economic success, will these nations eventually develop past the need for underage labor?

To summarize, palm oil has been proven to offer many socioeconomic benefits, including acting as a mechanism to provide prosperity to rural farmers, increasing national income, and improving the infrastructure of communities surrounding plantations. However, criticisms of the industry include the unfair share of profits to regional economies, social conflicts, and underage labor. The net effect of the industry varies by location, and ultimately every stakeholder will have a differing opinion on which effects carry more weight. As the industry changes, the goal should be to maintain those beneficial socioeconomic impacts while attempting to mitigate the issues.

Environmental Impacts

It is important to understand the environmental impacts of palm oil's cultivation in order to determine its sustainability. With scientists warning against the imminent threats of global warming and communities being affected by increasing changes and catastrophes, it is arguably more important than ever to understand how industry and consumer habits are affecting the environment. It can be a divisive topic, as there is no correct answer for how to balance the tradeoffs between benefiting current populations and reducing harm to future generations, but this section will attempt to summarize both the positive and negative impacts of the palm oil industry on the environment.

A huge criticism of palm oil is the deforestation that its expansion has caused. The most successful lands for cultivation often are incredibly diverse and carbon-rich forests (Pacheco et al., 2020). In addition to land suitability, establishing plantations in peatlands and forestland provide the opportunity to cover costs with selling timber extracted, as well as a reduced risk of land conflicts since the land is not yet settled. But these tradeoffs for large companies are argued not to be worth the environmental impacts, as the land conversion causes large carbon emissions and the loss of the diverse flora and fauna found in the forests (Paterson & Lima, 2018). The countries with the highest carbon emissions in their region from forest loss are Brazil, Democratic Republic of Congo, and Indonesia, which all have large palm oil industries. For example, plantation expansion in Kalimantan, Indonesia was expected to contribute between 18 and 22 percent of the country's carbon emissions in 2020. Deforestation has also led to devastating fires and environmental crises such as those caused by the El Niño in 2015 (Pacheco et al., 2020).

The risk for these potentially devastating effects both to the environment and the future of palm oil cultivation is heightened by the high concentration of cultivation in few countries such

as Malaysia and Indonesia. This increases the threats stemming from climate as well as locally adapted pests and pathogens (Paterson & Lima, 2018). As climate change worsens, environmental regulation decreases, and deforestation continues, it will become increasingly harder to cultivate oil palm. This will be detrimental to those who rely on palm oil for a living but will eventually have some reversal effects in carbon emissions as less cultivation and therefore deforestation can occur. Further environmental complaints derive from pesticide use in palm oil plantations. Indigenous communities in Brazil argue that contamination of rivers has led to adverse effects on local crop production, livestock, and the health of community members (Brandão & Schoneveld, 2015). However, it is unclear whether pesticides have actually contaminated the rivers, and scientists have yet to establish casualty between plantation pesticides and those issues identified by communities.

However, palm oil seems to have less adverse environmental impacts compared to alternatives due to more beneficial carbon sequestration characteristics (Jensen et al., 2019). A study on tax policies in Thailand found that reallocating land from palm oil towards other agricultural crops would increase greenhouse gas emissions by 7.5 megatons over 20 years. This is due to the structure of palm oil's value chain, with smallholders growing palm oil on marginal lands that lack significant alternative carbon sequestration potential. Replacing land used for cattle farming to palm oil plantations also causes a net lowering of greenhouse gas emissions, with carbon debt becoming net carbon sinks 7.2 years after conversion. (Brandão & Schoneveld, 2015). In addition, palm oil has a better Water Footprint than alternative crops. Since it is produced in the tropics, the oil palm trees are rain fed and do not require irrigation (Subramaniam et al., 2020). Many other crops require irrigation, such as the sunflower whose Water Footprint is dominated 82 percent by irrigation and other direct water application.

Alternatively, studies have found that the water used in palm oil cultivation has minimal impact in places with high rainfall. Palm oil mills have the highest water usage of the value chain, but this usage can be limited by avoiding dilution.

Another important thing to consider is the potential use of palm oil as biofuel, a renewable energy source. The governments of developed nations see biofuel as a way to hit climate targets and increase the security of their energy supply, and developing nations see it as a way to further connect to international markets (Boons & Mendoza, 2010). Biomass is better for the environment than fossil fuels because it is carbon neutral, meanwhile fossil fuels are not. Fossil fuels produce more greenhouse gases and therefore are a bigger contributor to climate change. More research is needed to see just how environmentally friendly biofuels are and if they offer a serious future in the energy world. There is little incentive to produce palm-based biodiesel under current market conditions in some places such as Brazil, as auction prices are not covering the cost of production (Brandão & Schoneveld, 2015). However, other places are more profitable, allowing for biofuel and energy to account for 15.1 percent of palm oil's market volume share in 2019 (Palm Oil Market Size, Share | Industry Analysis Report, 2020-2027, 2020). View the appendix for a visual of this market volume share. As policies are being created that will likely increase the demand for biofuels, the industry must figure out how to efficiently increase the scale of biofuel production to improve the profitability of this sector.

All and all, the environmental impacts of palm oil are not all good or all bad. Clearly, converting forests and using land to cultivate palm oil is worse than not doing any mass activity on the land. However, palm oil appears to have fewer negative environmental impacts than alternative uses of land such as cattle farming or farming requiring irrigation. People need to work and to eat, so activity will continue. Thus, the focus becomes how to minimize

deforestation and environmental impacts so that the land can remain healthy and be used for generations to come.

Prognosis

While standing in an oil palm plantation and hearing the perspective of a local, it seemed a no-brainer that the industry was detrimental and took advantage of communities in developing nations. Upon seeing the complexities of the industry, including the complexities of the value chain and the controversial socioeconomic and environmental impacts, it is clear that this is not fully the case. The solution is not to pressure the removal of palm oil all together. Despite the issues discussed, it seems that many detriments are not unique to palm oil, as they are seen with other industries, often times worse. I believe that palm oil offers many benefits compared to its alternatives, and that it has the potential to both mitigate its issues and improve its sustainability. The best ways to do this are to encourage regulation and certification, educate smallholders, and demand more accountability.

Currently, the main certifying body for palm oil is the Roundtable for Sustainable Palm oil (RSPO). It functions as a space for actors of both producing and consuming countries to jointly develop notions of sustainability for their activities in the product chain (Boons & Mendoza, 2010). As of 2015, RSPO certified palm oil accounted for 15 percent of global production. The RSPO is considered far more successful than similar bodies concerning commodities such as soybean, sugarcane, cotton, seafood, and beef (Noor et al., 2017). In addition to the RSPO, there are four other certification schemes with different principles and criteria. This includes the Indonesia Sustainable Palm Oil (ISPO), which is nationally mandatory and works to ensure growers follow a minimum set of best practices in order to have higher agricultural standards. Other countries are considering following suit. In European markets, there is currently a 30-dollar premium per ton for RSPO certified palm oil, which covers the costs for initial certification set up and continued costs of 15 dollars per ton (Brandão & Schoneveld,

2015). This shows that consumer demands and willingness to pay a premium have the power to influence more certified oil.

Despite the importance of certification, it has not yet provided sufficient results as evidenced by the Girl Scouts petition and the continuing sustainability issues. This is due to an uneven distribution of incentives along the value chain, complexity in tracing, difficulties with the expanding market, and alternative markets with lower standards (Noor et al., 2017). Part of the criticism for palm oil's sustainability discussed prior was the unfair profit sharing in the value chain. Certification has not helped with this, as strict standards often place greater burden of compliance on smallholders, instead of on the large companies who have more resources and gain larger shares of profit (Noor et al., 2017). It is also more cost effective for vertically integrated companies that control their own value chain to comply with sustainability standards. These types of companies, however, are the minority for the global industry. Therefore, smallholders struggle to comply with standards and are at risk for being eliminated from the value chain.

A major shortcoming currently is that the majority of the sustainable criteria for the roundtables has not been turned into enforceable policies and are therefore left to interpretation by individual nations (Boons & Mendoza, 2010). This is an important action item for the industry, as it needs to ensure that sustainability goals are met with productive change. Only with set goals and regulations will members of the value chain be held accountable.

As mentioned, a big problem for consumer confidence is the mixture of sustainably sourced palm oil with other sources throughout the value chain (Noor et al., 2017). As of 2014, only 14 percent of RSPO certified suppliers had sufficient documentation of their entire value chain to prove their sustainable claims. This is another instance where the need for greater

accountability comes into play. Places like the Netherlands are placing pressure on biofuels company to provide proof of their sustainable value chain (Boons & Mendoza, 2010). This needs to be expanded for all markets for palm oil. The more external pressure and demand for transparency placed on the industry, the more accountable and sustainable it will need to become. Pressure from consumers, NGO's, governments, and other stakeholders can have a real effect, especially if they work together.

In addition to this voluntary certification and pressures to improve, there needs to be more governmental and industry regulation that is both mandatory and enforceable. Private and public partnerships are widely seen as crucial, specifically for regulating the formality and competitiveness of the sector as well as making production limits to protect land (Pacheco et al., 2020). Laws and regulations, when enforced, can help to protect the peatland and forestland, prevent child labor, and mitigate the other issues within the value chain without eliminating the industry altogether. This will require commitment and resources from nations and companies to protect their citizens, workers, and land. The industry in Brazil is a great example of how this can work. With companies there complying to institutional and regulatory conditions, focusing on the wellbeing of their employees, and remaining committed to reducing their environmental footprint, the sector has showed the ability to expand sustainably and inclusively (Brandão & Schoneveld, 2015).

Finally, the industry must do a better job educating and giving resources to smallholders. Although there is some doubt to the effectiveness of smallholder cultivation, it would not be helpful or completely ethical to tell local communities not to plant palm oil and denounce their search for a piece of the profits. However, efforts from the internal and external stakeholders can help give smallholders the information and resources needed to make their own educated

decisions and be successful. More fully integrating smallholders into the supply chains makes it so that supply and demand side objects can better be achieved (Brandão & Schoneveld, 2015). Integration includes providing the capital and technical expertise to make certification a viable option for smallholders as well as to help increase the productivity of their land. This will not only help the financial success of the smallholders but will also help lower the environmental impacts as well. The managerial and biological tools exist to overcome challenges and improve production, they just need to better support and implementation (Paterson & Lima, 2018). In addition, there should be an increase in inseting, which is the investment in community capital (Noor et al., 2017). This works as a form of Corporate Social Responsibility which has been proven to help smallholders better manage resources. It allows smallholders to manage their production of palm oil more efficiently while also learning how to diversify their income in order to improve their opportunities and livelihoods. These activities become internalized to the company and aims to create value for all participants.

Conclusion

It is vital to note that this analysis is written from the perspective of a Western consumer. Using my international education and experiences, I have attempted to explain the issue as best as I can, but there are limitations to my understandings and ability to explain all sides. My problems in analyzing the research and coming to a conclusion are similar to that as certifiers—there are many different conclusions based on the weight given to each stakeholder and to each sustainability concern. There is no set definition of sustainability, which is important to remember when analyzing an industry and is the reason I had to choose my own definition. The main pillars of sustainability focused on—social, economic, and environmental—all reinforce and influence each other and the future of the industry, containing both benefits and harms. In addition, there are so many complexities to the industry, both horizontally and vertically. Horizontally, every region producing palm oil has its different strengths and weaknesses, regulations, and sustainability goals. These nuances make it hard to diagnose main problems or give solutions that will fit everywhere. Diagnoses also highly depend on what studies have been conducted and analyzed. Vertically throughout the global value chain, there are many different stakeholders and complexities, such as found with the complications of the green and brown supply chains. This makes it hard to find a clear solution to improve criticisms that will affect the whole value chain, especially without placing unfair burden on certain stakeholders.

Although palm oil has its idiosyncrasies, the industry represents problems found with typical global value chains. A lack of international governance complicates global value chains. With an industry distributed across many nations, each place has its own governmental regulations. There is no overall industrial body that can make and implement decisions, which makes it hard to solve issues and generate real change. This is why certification is so important, even if it is only voluntary. When a decision is made at any level of global value chains,

tradeoffs will be made. Stakeholders have different values and capabilities, so their interests vary. Because of this, decisions made will benefit one stakeholder while they hurt another.

These realizations about the palm oil industry will be very important moving forward as a consumer making purchasing decisions, not just with palm oil but with all goods. I will be able to analyze my products with a more critical lens, especially when evaluating whether the sustainability and certifying labels are actually meaningful and traceable, or a muddled attempt to charge a premium. Smart purchasing decisions require more than just looking for sustainability labels but learning how to read them. In order to place pressure on industries to do better, consumers need to understand the issues and the impacts of their decisions. I will be able to have those conversations with friends where I can share what I have learned, such as explaining that sustainable certifications are not highly regulated and transparent like that of FDA organic certifications. In addition, I have learned not to blindly trust one perspective on an issue, but to learn about the viewpoints and complications facing it from all sides and from all stakeholders.

My advice to Olivia Chaffin, the Girl Scout advocate, is to continue to focus and work on these important issues, to educate yourself, and to lobby together with different organizations to help people globally. Getting rid of Girl Scout cookies, however, is not the answer. The alternatives to palm oil are not necessarily better, and therefore boycotting would likely do more harm than good. Boycotting would just shift the demand to other oils, which would cause many of the same issues but on a greater scale due to the increased quantity of land needed. It would also hurt people throughout value chain. Instead, we should advocate for more sustainable palm oil—rewarding sustainable practices instead of punishing the industry. As consumers, we have real power to influence an industry to do better. Using this power responsibly requires using an

unbiased, critical eye and putting in hard work to research and promote positive change.

Consumer demand for sustainable oil pressures food and cosmetic companies to source from certified suppliers, and this pressure then filters through to growers. Girl Scout cookies are more than just a tasty snack—they support livelihoods around the world, as well as fund the important mission to build girls of confidence and character that make the world a better place. Those girls may even grow up to find solutions to the issues with palm oil and other industries. A better solution for Olivia would be to encourage the Girl Scouts to advocate for better, more meaningful palm oil certifications. If the Girl Scouts—as well as consumers, governments, NGO's, and companies—hold the industry accountable for sustainability metrics, great change can happen.

References List

- Alam, A. S. A. F., Er, A. C., & Begum, H. (2015). Malaysian oil palm industry: Prospect and problem. *Journal of Food, Agriculture and Environment*, 1313, 143–148.
- Boons, F., & Mendoza, A. (2010). Constructing sustainable palm oil: How actors define sustainability. *Journal of Cleaner Production*, 18(16), 1686–1695.
<https://doi.org/10.1016/j.jclepro.2010.07.003>
- Borrello, M., Annunziata, A., & Vecchio, R. (2019). Sustainability of Palm Oil: Drivers of Consumers' Preferences. *Sustainability*, 11(18), 4818. <https://doi.org/10.3390/su11184818>
- Brandão, F., & Schoneveld, G. (2015). *The state of oil palm development in the Brazilian Amazon: Trends, value chain dynamics, and business models*. CIFOR.
- Dürr, J. (2017). Sugar-Cane and Oil Palm Expansion in Guatemala and its Consequences for the Regional Economy. *Journal of Agrarian Change*, 17(3), 557–570.
<https://doi.org/10.1111/joac.12150>
- Hyatt, D. (n.d.). *Defining Sustainable Products*. 17.
- Jensen, H. T., Keogh-Brown, M. R., Shankar, B., Aekplakorn, W., Basu, S., Cuevas, S., Dangour, A. D., Gheewala, S. H., Green, R., Joy, E. J. M., Rojroongwasinkul, N., Thaiprasert, N., & Smith, R. D. (2019). Palm oil and dietary change: Application of an integrated macroeconomic, environmental, demographic, and health modelling framework for Thailand. *Food Policy*, 83, 92–103. <https://doi.org/10.1016/j.foodpol.2018.12.003>
- Lim, C. I., & Biswas, W. (2015). An Evaluation of Holistic Sustainability Assessment Framework for Palm Oil Production in Malaysia. *Sustainability*, 7(12), 16561–16587.
<https://doi.org/10.3390/su71215833>

- McDowell, R., & Mason, M. (2020, December 29). *Child Labor In Palm Oil Industry Tied To Girl Scout Cookies*. HuffPost. https://www.huffpost.com/entry/palm-oil-child-labor-tied-to-girl-scout-cookies_n_5feb3a97c5b6e1ce833ca2d8
- Nasution, A., Fajri, Karim, A., & Romano. (2020). The Effect of Sustainable Pillars (Economic, Social, Environmental) and Security Factors on Sustainable Palm Oil in Nagan Raya District—Aceh. *Systematic Reviews in Pharmacy*, 11(3), 441–450. <https://doi.org/10.5530/srp.2020.3.56>
- Noor, F. M. M., Gassner, A., Terheggen, A., & Dobie, P. (2017). Beyond sustainability criteria and principles in palm oil production: Addressing consumer concerns through inseting. *Ecology and Society*, 22(2). <https://www.jstor.org/stable/26270132>
- Pacheco, P., Schoneveld, G., Dermawan, A., Komarudin, H., & Djama, M. (2020). Governing sustainable palm oil supply: Disconnects, complementarities, and antagonisms between state regulations and private standards. *Regulation & Governance*, 14(3), 568–598. <https://doi.org/10.1111/rego.12220>
- Palm Oil*. (n.d.). Our World in Data. Retrieved April 13, 2021, from <https://ourworldindata.org/palm-oil>
- Palm Oil Market Size, Share / Industry Analysis Report, 2020-2027*. (2020). Grand View Research. <https://www.grandviewresearch.com/industry-analysis/palm-oil-market>
- Paterson, R. R. M., & Lima, N. (2018). Climate change affecting oil palm agronomy, and oil palm cultivation increasing climate change, require amelioration. *Ecology and Evolution*, 8(1), 452–461. <https://doi.org/10.1002/ece3.3610>

Purnomo, H., Okarda, B., Dermawan, A., Ilham, Q. P., Pacheco, P., Nurfatriani, F., & Suhendang, E.

(2020). Reconciling oil palm economic development and environmental conservation in

Indonesia: A value chain dynamic approach. *Forest Policy and Economics*, 111, 102089.

<https://doi.org/10.1016/j.forpol.2020.102089>

Spicer, A., & Hyatt, D. (2017). Walmart's Emergent Low-Cost Sustainable Product Strategy.

California Management Review, 59(2), 116–141. <https://doi.org/10.1177/0008125617695287>

Subramaniam, V., Hashim, Z., Loh, S. K., & Astimar, A. A. (2020). Assessing water footprint for the oil palm

supply chain- a cradle to gate study. *Agricultural Water Management*, 237.

<https://doi.org/10.1016/j.agwat.2020.106184>

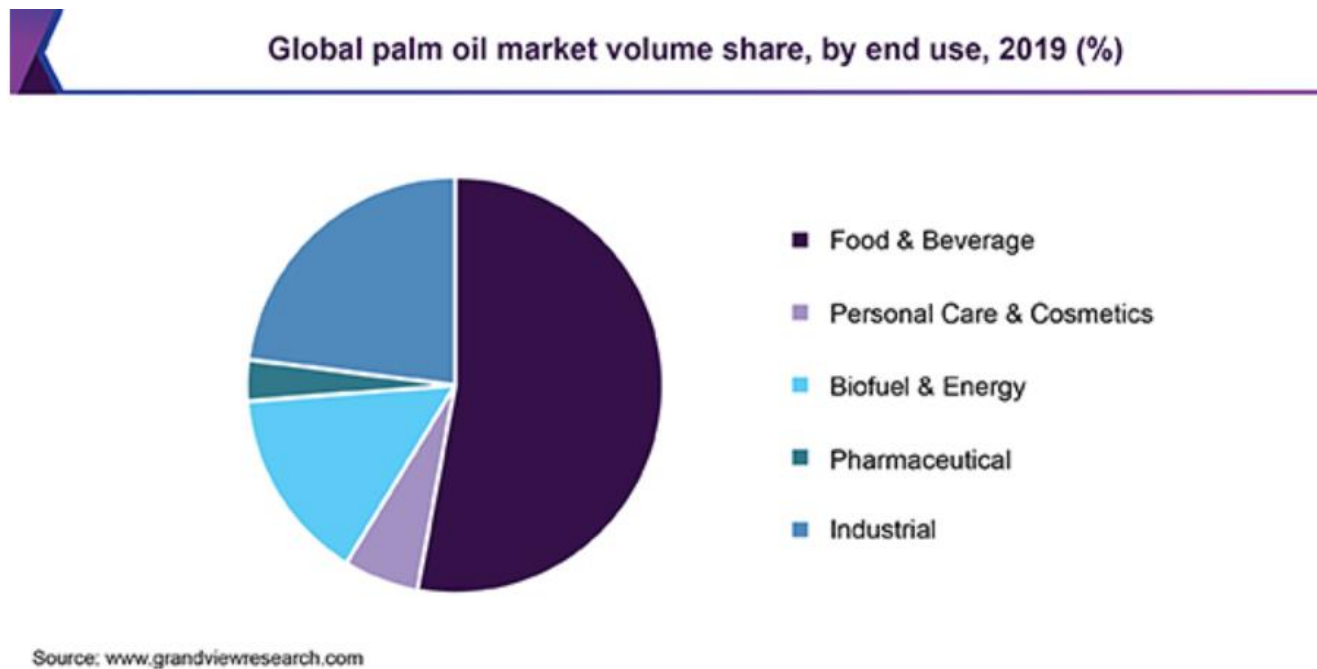
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<https://doi.org/10.1016/j.agwat.2020.106184>

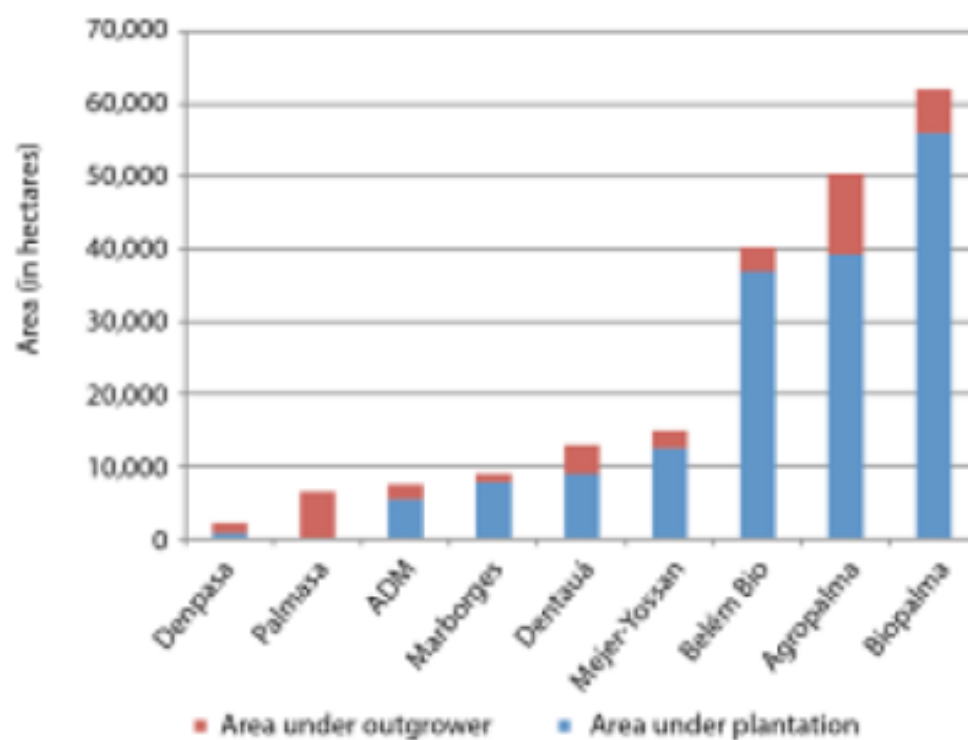
APPENDIX

Figure 1. Market Volume Share



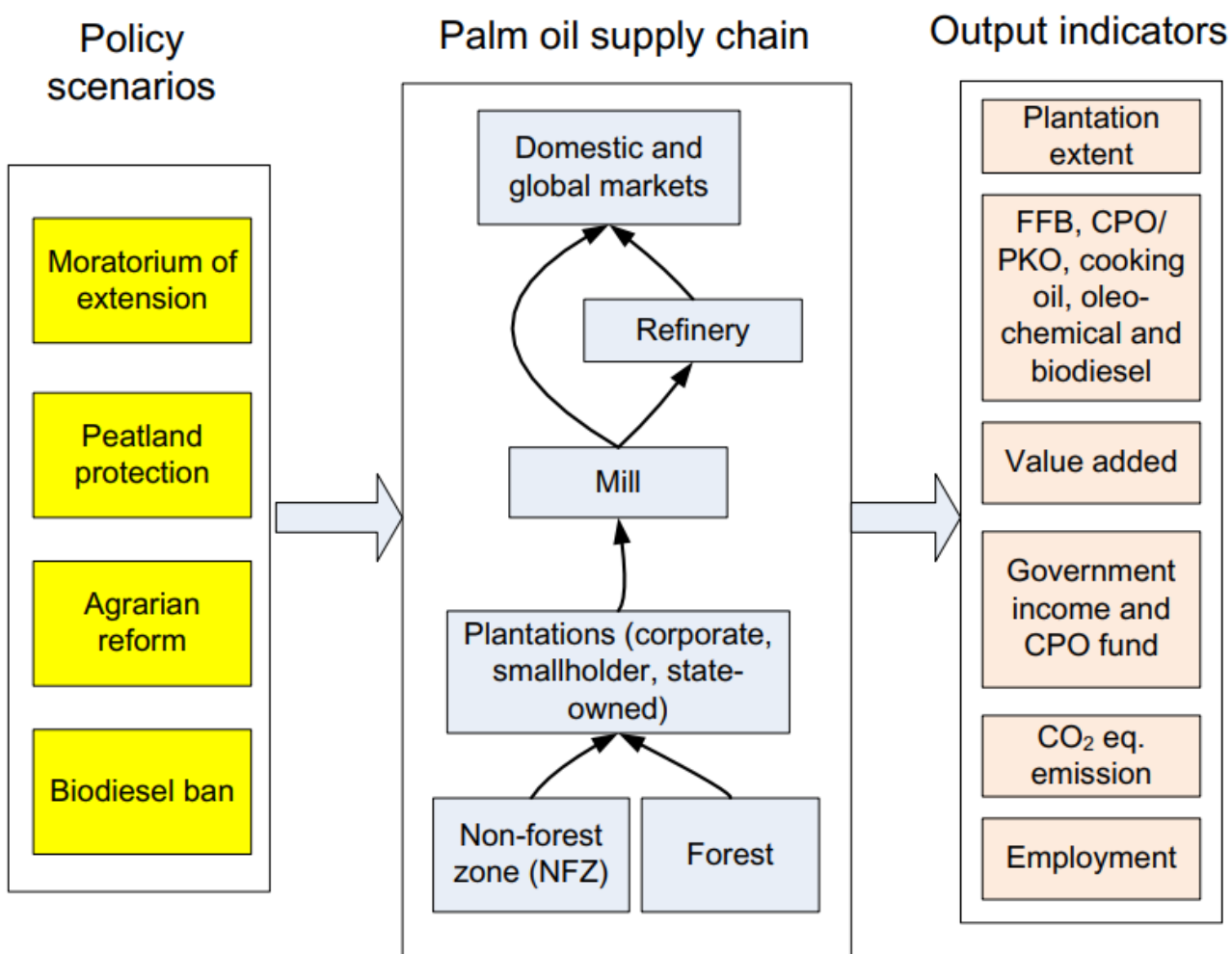
Source: (*Palm Oil Market Size, Share / Industry Analysis Report, 2020-2027*, 2020)

Figure 2. Area by Production Type in Brazil



Source: (Brandão & Schoneveld, 2015).

Figure 3. Supply Chain Example

**Fig. 2.** Architecture of the Indonesian Palm Oil Simulation (IPOS) model.

Source: (Purnomo et al., 2020)

Figure 4. Opportunity Cost of Sustainable Measures

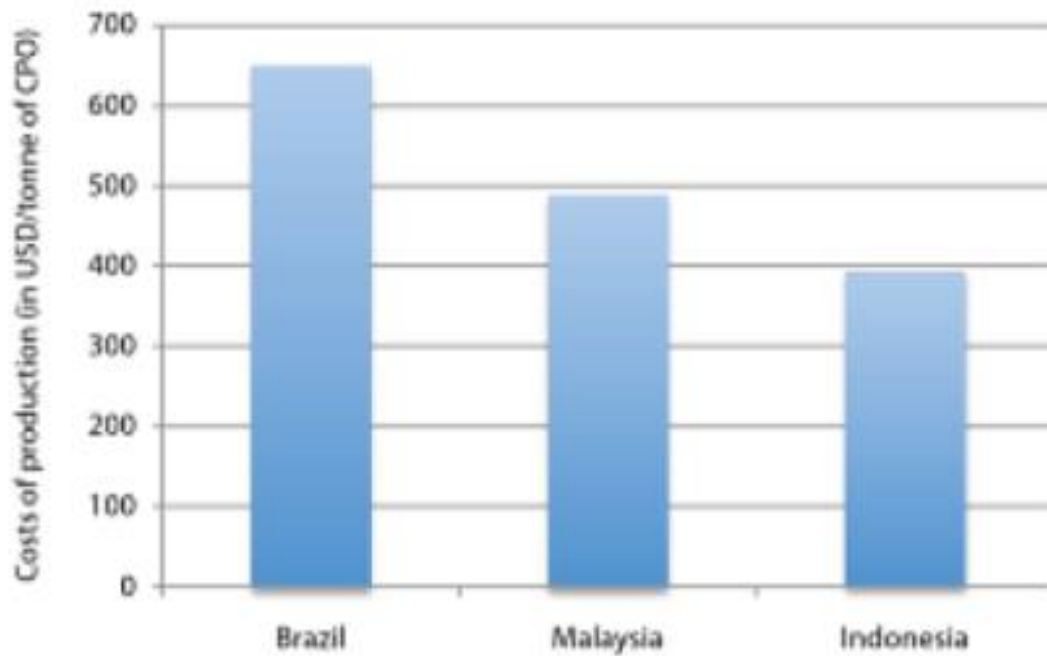


Figure 14. Cost of production in Brazil

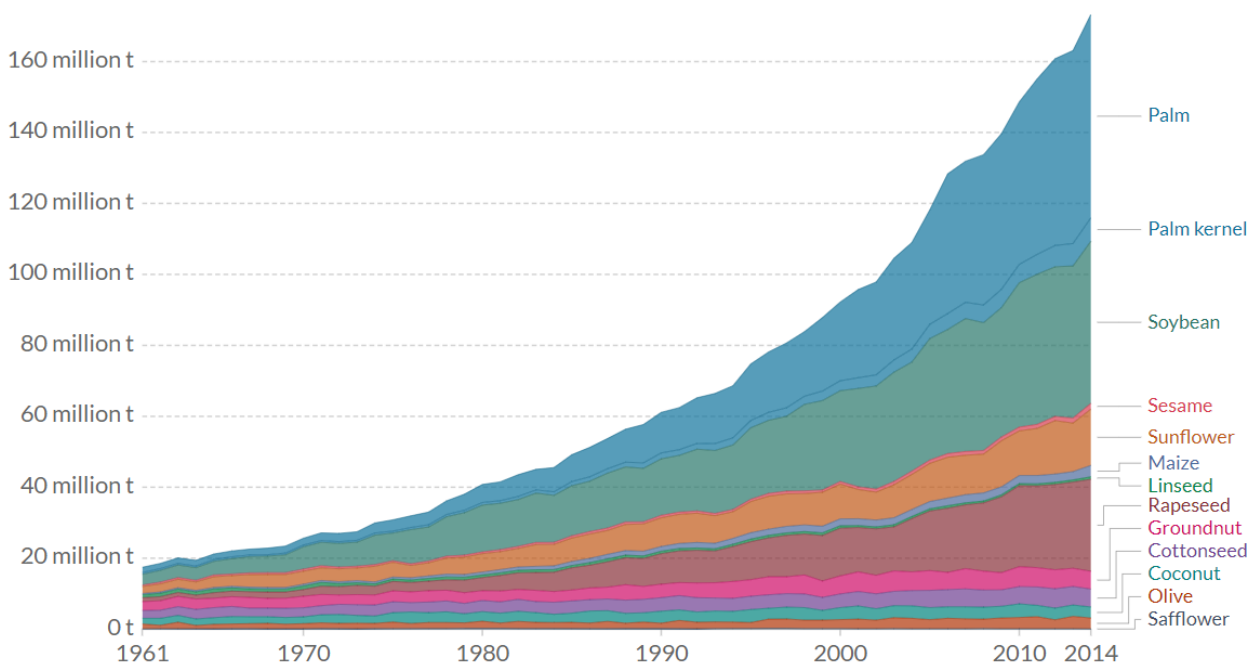
CPO = crude palm oil.

Source: Brito (2014); Budidarsono et al. (2012); ERE Consulting (2012)

Source: (Brandão & Schoneveld, 2015).

Figure 5. Vegetable Oil Breakdown

Vegetable oil production, World

Our World
in Data
[Change country](#)
☐ Relative


Source: UN Food and Agriculture Organization (FAO)

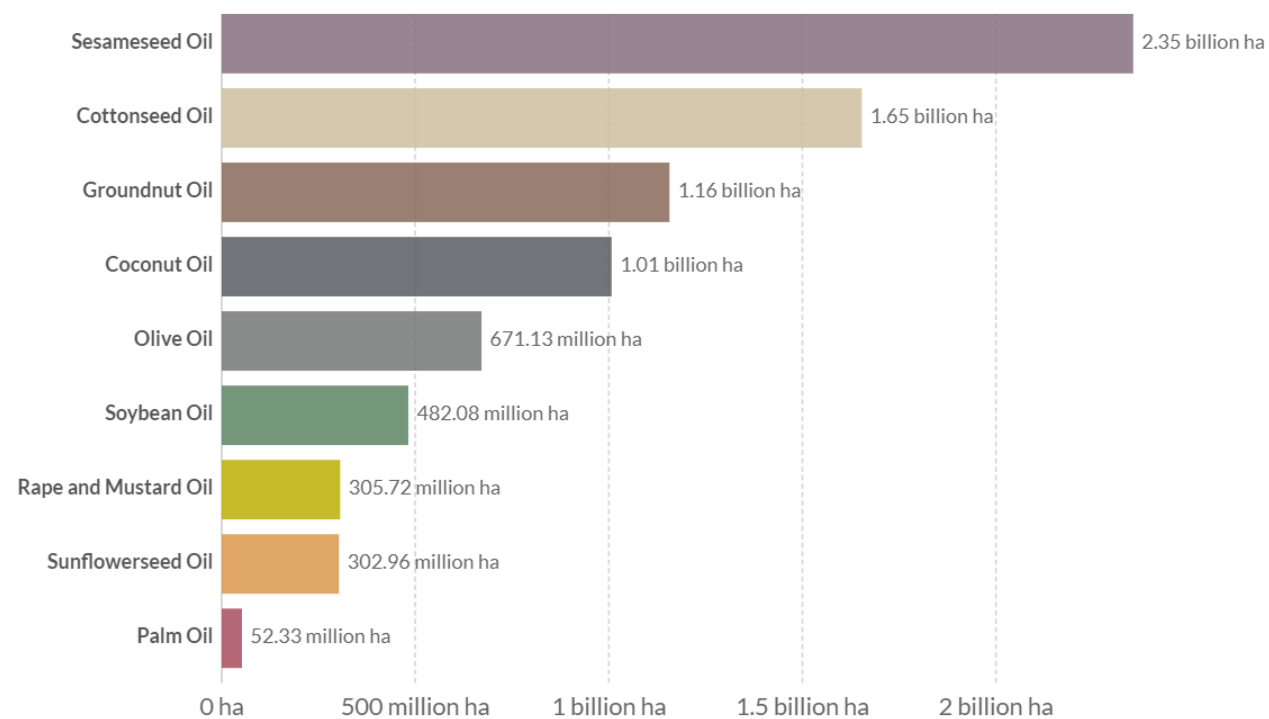
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Source: (*Palm Oil*, n.d.).

Figure 6. Land Needed to Meet Demand

Area of land needed to meet global vegetable oil demand, 2017

This metric represents the amount of land that would need to be devoted to grow a given crop if it was to meet global vegetable oil demand alone. Global vegetable oil demand was 210 million tonnes in 2017.



Source: Calculated by Our World in Data based on data from the UN Food and Agriculture Organization (FAO)

OurWorldInData.org/crop-yields • CC BY

Source: (*Palm Oil*, n.d.).